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## Enantioselective conjugate addition of diethylzinc to chalcone catalyzed by $\text{Co}(\text{acac})_2$ and chiral amino alcohols

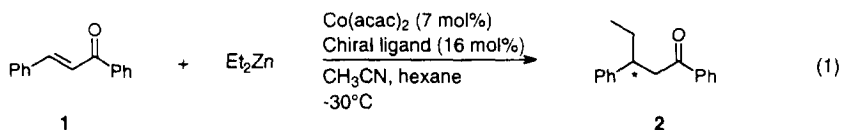
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**Abstract:**  $\text{Co}(\text{acac})_2$  in the presence of chiral ligands has been employed as catalyst for the enantioselective conjugate addition of diethylzinc to chalcone. With chiral amino alcohols derived from (+)-camphor, enantioselectivities up to 83% were achieved. © 1997 Elsevier Science Ltd

Conjugate addition reactions of carbon nucleophiles to  $\alpha,\beta$ -unsaturated compounds are among the most widely used methods for carbon–carbon bond formation in organic synthesis.<sup>1</sup> Asymmetric conjugate addition reactions, however, still lack the ‘ideal chiral catalyst’ which promotes enantioselective conjugate addition of readily available organometallic reagents to a wide variety of substrates.<sup>2</sup> Considerable progress has been made with the copper catalyzed conjugate addition of Grignard reagents<sup>3</sup> and the nickel catalyzed conjugate addition of diethylzinc.<sup>4</sup> Also a copper catalyzed 1,4-addition of diethylzinc to cyclohexenone has been reported.<sup>5</sup> Recently, we and others have found the first catalytic system capable of the enantioselective conjugate addition of dialkylzinc reagents to *both* cyclic and acyclic substrates.<sup>5</sup>

Although transmetallation reactions of organozinc reagents to several metal salts have been proposed,<sup>6</sup> Knochel and co-workers recently reported the first synthetically useful transmetallations of organozinc reagents to *cobalt* in acylation and allylation reactions.<sup>7</sup> The use of organocobalt reagents in conjugate addition reactions has been limited.<sup>8</sup> Herein we describe catalytic enantioselective conjugate addition reactions of diethylzinc to chalcone using  $\text{Co}(\text{acac})_2$  and chiral amino alcohols (Equation 1).

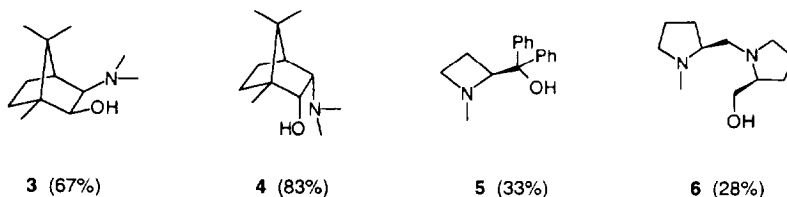


When  $\text{Co}(\text{acac})_2$  (7 mol%) and chiral amino alcohol **3** (16 mol%) were employed in the model reaction the 1,4-product **2** was isolated in 61% yield (70% conversion according to GC analysis, after 16 h at  $-30^\circ\text{C}$ ).<sup>9</sup> No 1,2-addition was observed and chiral HPLC analysis<sup>9</sup> revealed an enantioselectivity of 67%.

Three other chiral amino alcohol ligands **4–6** were also examined in the model reaction. With ligand **4** product **2** was isolated in 73% yield with an e.e. of 83%. Ligands **5**<sup>10</sup> and **6** gave substantial lower conversions to the 1,4-product (~50%) and moderate e.e.'s (see Figure 1).

Using chiral amino alcohols the cobalt catalyzed conjugate addition is relatively slow compared to the nickel catalyzed reaction (>95% conversion to the 1,4-product **2** after 2 h at  $-30^\circ\text{C}$ )<sup>4c</sup> and a considerable amount (5% with ligands **3** and **4**, 20% with ligands **5** and **6**) of the reduced by-product 1,3-diphenylpropan-1-one has been detected.<sup>11</sup> However, relatively high enantioselectivities were found in this reaction and moreover transmetallation processes of organozinc reagents to cobalt seem to have a greater applicability in (enantioselective) organic reactions<sup>7</sup> than transmetallation to

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**Figure 1.** Chiral amino alcohols used in the  $\text{Co}(\text{acac})_2$  catalyzed addition of  $\text{Et}_2\text{Zn}$  to **1**. In brackets the e.e. of product **2** achieved with the given ligand.

other metal salts.<sup>12</sup> Therefore, further studies involving enantioselective cobalt mediated reactions of organozinc reagents are in progress in our laboratories.

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